

CLAIMS

1. An integrated cryopump and 2 stage pulse tube refrigeration system comprising a cryopump, a compressor for a pulse tube refrigerator, a pulse tube refrigerator located within the vacuum chamber of the cryopump where the refrigerator comprises first and second stage regenerators connected to the compressor via a valve assembly external to the cryopump vacuum chamber at one end and connected to the cold station of first and second stage pulse tubes, respectively, at the other end, and

the hot ends of the pulse tubes are connected to each other through a buffer volume,

the hot ends of the pulse tubes are integral to the cryopump vacuum chamber housing, and

a buffer volume is connected to the hot ends of the pulse tubes through flow restrictors.

2. An integrated cryopump and 2 stage pulse tube refrigeration system comprising a cryopump, a compressor for a pulse tube refrigerator, a pulse tube refrigerator located within the vacuum chamber of the cryopump where the refrigerator comprises first and second stage regenerators connected to the compressor via an active valve assembly external to the cryopump vacuum chamber at one end and connected to the cold station of first and second stage pulse tubes, respectively, at the other end, and

the hot ends of the pulse tubes are connected to each other through a buffer volume,

the hot ends of the pulse tubes are integral to the cryopump vacuum chamber housing,

the active valve assembly for the pulse tube refrigeration system is at the bottom or side of the cryopump vacuum chamber housing,

the gas inlets for the pulse tube refrigeration system are at the bottom or back of the cryopump vacuum chamber housing,

the cryopump inlet is on the side of the cryopump vacuum chamber housing, and

a buffer volume is connected to the hot ends of the pulse tubes through flow restrictors.

3. The system of claim 1 where the gas inlets for the pulse tube refrigeration system are at the bottom of the cryopump housing.

4. The system of claim 1 where the gas inlets for the pulse tube refrigeration system are at the back of the cryopump housing.

5. The system of claim 1 also comprising a bypass line from the regenerator inlet line to the buffer volume and restrictors in the line.

6. The system of claim 1 also comprising a bypass line from the compressor inlet and outlet lines to the buffer volume and active valves in the line.

7. The system of claim 1 where the second stage regenerator comprises two separate sections.

8. The system of claim 1 where the hot ends of the regenerators extend through the cryopump vacuum chamber housing.

9. The system of claim 1 where the refrigerator is an inline refrigerator.

10. The system of claim 9 where the gas inlets for the pulse tube refrigeration system are at the bottom of the cryopump housing.

11. The system of claim 1 also comprising a bypass line from the compressor inlet and outlet lines to the buffer volume and active valves in the line.

12. The system of claim 9 also comprising bypass lines connected directly from the compressor through active valves to the hot ends of the pulse tubes.

13. The system of claim 9 where the second stage regenerator comprises two separate sections.

14. The system of claim 9 where at least one of the hot ends of the regenerators is integral to the cryopump vacuum chamber housing.

15. The system of claim 14 where the hot ends of the regenerators are integral to the cryopump vacuum chamber housing.

16. The system of claim 9 where the second stage regenerator comprises two separate parts.

17. An integrated cryopump and 2 stage pulse tube refrigeration system comprising a cryopump, a compressor for a pulse tube refrigerator, a pulse tube refrigerator located within the vacuum chamber of the cryopump where the refrigerator comprises a split body regenerator comprising a hot section and a cold section where the hot end of the hot section is connected to the compressor via a valve assembly external to the cryopump vacuum chamber and the cold end of the hot section is connected to the cold station of a first stage pulse tube and to the warm end of the cold section of the regenerator,

the hot end of the first stage pulse tube is connected to the valve assembly,

the hot end of the second stage pulse tube is connected to a buffer volume, and

the hot ends of the pulse tubes are integral to the cryopump vacuum chamber housing.